Development of the Aerosonde Robotic Aircraft

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LONG-TERM GOALS

Our long-term goals are to develop improved means of obtaining observations from remote and dangerous locations using robotic aircraft.

OBJECTIVES

To continue development of the Aerosonde in support of Navy requirements, by:

1. Continued work to increase robustness and operational flexibility of the aircraft;
2. Development of new instrumentation and capacity; and,
3. Undertaking scientific field missions relevant to ONR research requirements.

APPROACH

The Aerosonde robotic aircraft is being developed to provide a flexible and low-cost observing platform for a wide variety of needs. The initial development phase produced the Mark 1 Aerosonde. This has been superceded by the Mark 2, which is in limited operations. We are continuing development to a multifunctional mark 4 by a combination of engineering development and extensive field-testing. The continued development is occurring on the basis of: specification of user and operational requirements; engineering design and specification; detailed costing and resource requirements; engineering development; test and evaluation; full documentation of the final system; operational acceptance.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 2001**	2. REPORT TYPE	3. DATES COVERED **00-00-2001 to 00-00-2001**

4. TITLE AND SUBTITLE **Development of the Aerosonde Robotic Aircraft**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Aerosonde Ltd,,41-43 Normanby Road,,Notting Hill, Victoria, 3168, Australia, ,**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
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15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT **unclassified**	b ABSTRACT **unclassified**	c THIS PAGE **unclassified**	**Same as Report (SAR)**	**7**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

The principal developments for future operations that are planned include the following. A Global Aerosonde Reconnaissance Facility is being developed that consists of a set of launch and recovery sites dispersed around the globe. The use of satellite communications and internet technology enables an operation in which all aircraft around the globe are under the command of a single center. During operation, users will receive data at their home institution in near real time via a Virtual Field Environment. Sophisticated applications of the Aerosonde are being enabled by the development of a variety of interchangeable instrument payloads and the operation of Smart Aerosonde Clusters (SmACs). This provides considerable economy of operation.

WORK COMPLETED

The Mark 3 Aerosonde became operational in 2001. It contains a new airframe, substantial upgrades to onboard electronics and software and a completely reworked engine with electronic fuel injection as one of the options.

Aerosondes continue to participate in a wide variety of field programs with over 3000 flight hours to date in the USA, Canada, Japan, Taiwan, Korea and Australia. We accomplished over 1500 flight hours during the year.

Commercial flights have commenced in agricultural survey and military trials have been or are scheduled in Australia and Sweden. We have responded to requests from NAVAIR and the Air Force for potential US military applications.

RESULTS

Research and development activities have continued on improvements to the basic system, on ice detection and amelioration and on instrument integration.

System upgrade work included:

- further upgrades to the avionics software to remove inconsistencies and bugs and to enable satellite communications;
- installation of the ORBCOM satellite communications capacity and its first operational use in the NASA CAMEX program;
- completion of the Mark 3-4 airframe and related systems, which has passed flight tests and is moving into production;
- move into operations for the Aerosonde Global Command Centre and the Aerosonde Virtural Field Environment.
- completion of the new fuel injected engine and trials under Arctic conditions;
- installation and testing of an ice detection and amelioration system;
- installation of cameras and an infrared sensor for surface temperature.

Additional activities have included:

- publication of the full Aerosonde vision and system in Holland et al (2001);
- ice detection and avoidance technology was tested in the laboratory and in field trials in the Arctic;
- instrument intercomparison tests have been drafted into a publication by Soddell et al (2001).

The advanced technology and relatively low cost of the Aerosonde makes possible unique experimental designs that use clusters of Aerosondes. We have called this operation of Smart Aerosonde Clusters (SmACs), in which a group of Aerosondes communicate with each other and make independent decisions on how to arrange themselves to conduct a defined mission. Initial design and development work has commenced in this area.

Full details on these developments can be found at www.aerosonde.com.

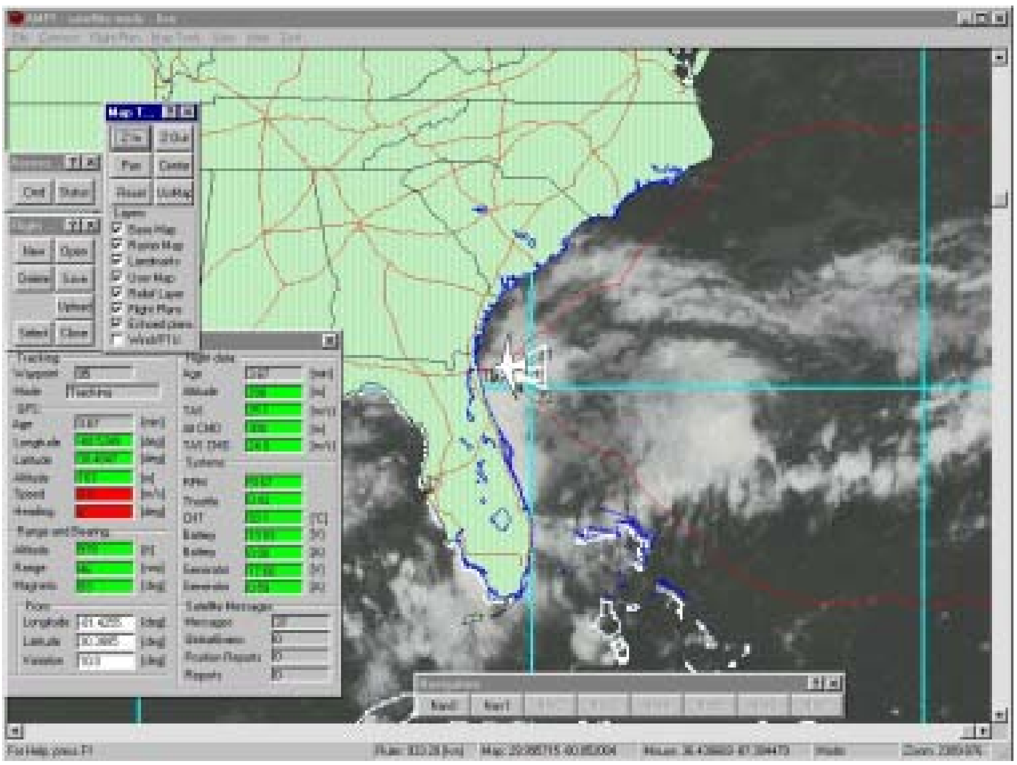

Figure 1: An Aerosonde operating off the east coast in the CAMEX program, shown on the Aerosonde Virtual Field Environment Display

Figure 2. The Aerosonde Mark 3

IMPACT/APPLICATIONS

ONR's vision in establishing and enabling the Aerosonde development program has lead to a major new system now being available for economical aircraft operation, particularly in remote and hazardous areas. As discussed in Holland et al. (2001), the Aerosonde enables flexible operations in a wide range of meteorological, environmental, biological and surveillance applications.

The potential is emphasized by extensive operations that have already been accomplished and by the widespread endorsement of the Aerosonde by international organisations including the WMO Commission for Atmospheric Sciences, the International Council of Scientific Unions, and the Executive Committee for the International Decade for Natural Disaster Reduction, and the ESCAP/WMO Typhoon Committee.

Recently funded applications include:

- A full Arctic reconnaissance Facility supported by NSF;
- Operations to demonstrate capacity and test systems by the US Navy, the NWS, the Japanese MRI, CATT and Frontier Program, the Taiwan Central Weather Bureau, the Korean METRI, the Australian Bureau of Meteorology and the Australian and Swedish Defence Forces;
- Research programs for NASA in CAMEX 4 and for the NSF in EPIC.

TRANSITIONS

The following transitions have occurred:

- Move to an operational system, with the Mark 2 and current transformation to the Mark 3 and 4 Aerosondes;
- Establishment of the Aerosonde Global Reconnaissance Facility with a Global Command Centre in Melbourne, Australia and a Virtual Field Environment to provide real-time results anywhere;
- The potential for use of the Aerosonde in military operations has been demonstrated and operational plans are being developed;
- Specialized instrumentation, including chemical sensors, camera systems, and communications relay capacity are being integrated.

RELATED PROJECTS

Our tropical cyclone program (ONR N00014-94-1-0493) has been working closely with the Aerosonde project on mutual programs of data collection and research into mesoscale aspects of tropical cyclones.

SUMMARY

The Aerosonde project originated out of a need for a capacity to take observations from remote regions and in dangerous conditions, such as severe weather. After a substantial design and development period, this need is being satisfied by the Aerosonde system.

The small aircraft (only 10ft in wingspan) is a flying robot with an avionics set as its “brain”. It utilises microcomputer technology, together with GPS for navigation and either a radio or satellites for communications. A substantial engine development program has produced a powerplant that keeps the aircraft aloft for over 30 h on 1.5 gallons of fuel. Launch is from a car roofrack and a belly landing is used for recovery.

Imagine next a robotic airline operating from a distributed set of launch and recovery sites, which can be located in almost any reasonably flat and clear area, with a global command center undertaking all of the scheduling and in-flight command, and a Virtual Field Environment to provide all relevant information to users. This is made possible by the enormous range and flexibility of the Aerosonde.

All of these components are now in operation and can be viewed in detail at www.aerosonde.com. The vision of ONR in providing the seed funds to commence the program and supporting a major component of the development has enabled a new observing system that is now being used around the world.

REFERENCES

Holland, G.J., P.J. Webster. J. Curry, G. Tyrrell, D.J. Gauntlett, G. Brett, J. Becker, R. Hoag and B. Vaglienti, 2000: The Aerosonde robotic aircraft: A new paradigm for environmental observations**.** *Bull. Amer. Met. Soc. (accepted).*

PUBLICATIONS

A number of field reports, including data are available from our web site at www.aerosonde.com.

Holland, G.J., P.J. Webster. J. Curry, G. Tyrrell, D.J. Gauntlett, G. Brett, J. Becker, R. Hoag and B. Vaglienti, 2000: The Aerosonde robotic aircraft: A new paradigm for environmental observations**.** *Bull. Amer. Met. Soc. (accepted)*.

Soddell, J.R., K. McGuffie, G.J. Holland and A., Sharp, 2001: Comparison of atmospheric soundings from Aerosonde and Radiosonde. *J. Appl. Meteor.* (in preparation).

PATENTS

Nil